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ABSTRACT

New technology, which is eliminating the barriers of time and distance, is also challenging the existence of traditional, geographically based campuses and curriculum based on textbooks. Universities need to update curriculum to conform to changes in the teacher's role from provider of knowledge to facilitator of life-long learning. Technological tools facilitate virtual meetings and group collaboration, and are motivating students to participate in their education. Tools are connecting students to colleagues, teachers, universities and libraries and are improving course quality by widening cohort groups. Technology provides an opportunity to make a university attractive by offering customers a unique service. This literature review paper looks at the four information technology fields (computer hardware, computer software, communications, and information services) which are changing the way people communicate, teach, and learn. It describes the change in the way knowledge is shared and delivered and looks at teachers' new role in education. The paper reviews the new technological tools that are being used to improve course quality and to provide distance education, looking at the advantages and problems that these tools cause. (Contains 67 references.) (Author/AEF)

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HOW INFORMATION TECHNOLOGY IS CHANGING EDUCATION

LITERATURE REVIEW

Societal Factors Affecting Education

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Four information technology fields - computer hardware, computer software, communications, and information services are driving a technological revolution (Kull, M. and Halal, 1998, p.2). The new tools of the computer and telecommunications industry are eliminating the barriers of time and distance, changing the source of information, and the mode of delivery. Technology has changed communications so that "everything is connected to everywhere" (Knoke, 1996, p.6). Telecommunications (sending and receiving information from a computer over long distance, using telephone wires) are changing the way we communicate, teach, and learn.

Forty-five percent of homes now have an average of 1.3 computers and by the year 2003, the number of computers in U.S. households will have increased by 60% from today's levels according to forecasts from INTECO Corporation (INTECO web site, 1998). We are becoming an "E-mail Nation" with one third of Americans now communicating by sending E-mail messages (Sklaroff, 1999). Technological tools such as E-mail, real time Internet chat, videoconferencing, and teleconferencing are all making it possible to communicate from our homes. These forms of telecommunications (which use a modem to send and receive signals from one computer to the other over the telephone lines) are eliminating the barrier of distance, allowing people to be anywhere (Male, 1988, p.125). Distance education provides the opportunities to: Reach a wider student audience, meet the needs of students unable to attend on-campus classes, involve outside speakers otherwise unavailable, and link students from different social, cultural, economic, and experiential backgrounds (Willis, B. 1995). "Research comparing distance education to traditional face-to-face instruction indicates that teaching and studying at a distance can be as effecti8e as traditional instruction, when the method and technologies used are appropriate to the instructional tasks, there is student-to-student

interaction, and when there is timely teacher-to-student feedback (Moore & Thompson, 1990; Verduin & Clark, 1991). Research indicates that the instructional format itself (e.g., interactive video vs. videotape vs. "live" instructor) has little effect on student achievement as long as the delivery technology is appropriate to the content being offered and all students have access to the same technology. Research also suggests achievement on various tests tends to be higher for distant as opposed to traditional students (Souder, 1993). Distance students are successful because of the basic characteristics they bring to their learning experience. They are voluntarily seeking further education, have post-secondary education goals with expectations for higher grades (Schlosser and Anderson, 1994), are higher motivated and self-disciplined, and are older (Willis1995, October).

Many universities give students an E-mail account, which enables the student to access the university on-line library, bulletin boards, discussion groups, and forums on the World Wide Web. Some universities purchase software packages (such as WEBCT) which include web links, chat rooms, and threaded discussion forums for faculty to use for distance communication in on or off campus classes (Sonoma State University, WebCT home page).

Internet Relay Chat (IRC) was the original chat medium on the Internet and is still the most widely used. This computer software program allows group chat as well as private talk by typing messages, which are sent instantly (IRC web site, 1999). I Seek You (ICQ) is a similar software program which can be downloaded free for a limited time. This program alerts the subscriber when other members are on-line. ICQ allows members to play games and to send messages by voice or writing in real time (with immediate response). In multi-user mode, groups can conduct conferences (ICQ web site, and Sonoma State web page).

E-mail alone is one way communication. With E-mail, one can't get feedback on how the communication is being accepted, as can't hear the tone of voice or see the facial expression. For many, questions about appropriate use have necessitated E-mail acceptable use policies at work and school. For times when E-mail is too impersonal, the computer can be turned into a videophone, a device that allows a phone line to carry motion video and audio signals, allowing "simulated visits". By adding speakers, a soundcard, and a microphone ($60) to the home computer, one can communicate inexpensively by voice over the Internet just as if using a telephone, usually without long distance phone charges beyond the usual monthly Internet service fee. By adding a camcorder or digital camera, one can videoconference by voice with visual capabilities with another person who has similar capabilities anywhere in the world.

See You See Me (Cu-SeeMe) is free desktop videoconferencing software developed at Cornell University. Cornell's CU-SeeMe Reflector is a server where several users can connect, allowing multi-participant video conferencing (Cu-SeeMe web site 1999). For those without a computer, a VC-55 software package allows one to use their own phone, camcorder, and TV set to videoconference, use the Internet, and E-mail ($366) (Videophone web site 3/11/99). Companies such as Tiger Direct offer mobile videoconferencing kits ($400) and notebook TVs ($280) that allow communication without the need for external power. They plug into and are powered from a conference card, and allow sending video mail and conducting live meetings with colleagues around the world (Tiger Direct). Japan recently produced a mobile videophone (BB210) that operates at two frames per second and sells for $325.00 (ITN 7:00 PM news May 18, 1999, Channel 58 with Dalget Daliwal).

Businesses are teaming up with education to share information and expertise (Hines, A. 1994, p.3). Companies such as Picture Tell offer software for $330 that allows four sites to

appear simultaneously on each monitor, allowing multiple sites to participate in the same conference (Picture Tell web site, 1999). Caliber Learning Network, Inc. offers conference tools with satellite for large events, such as studios for faculty members to deliver content and instruction to audiences. The National University Teleconference Network (NUTN), a satellite networking organization for higher education, organizes communication networks for information flow (Grantham, J. ,1985). In the race for a share of the distance education market, new partnerships are forming daily, such as: The Apollo Group (a parent company of the University of Phoenix), working with Hughes Network (a satellite company) to create a company devoted to distance education (Chronicle Eds., Sept. 4, 1998), and Motorola Internet and Aureal Semiconductor forming a strategic alliance to create and market communication solutions such as an integrated three-D audio/modem card (Multimedia Insider, Oct. 28,1998, Vol. 1 No.6).

One of the benefits of telecommunication for students is that they are more willing to take risks in expressing themselves freely with E-mail (Tamashiro, 1987 as reported by Male). Students feel like equals as there are no isolating factors (no one can see thei. race, appearance disability, etc.). Another advantage of telecommunication activities is that when actions don't occur in real time, students have the opportunity to look up information, think about and revise responses. There is no time pressure in communicating (Tamashiro, 1987, p.127).

Telecommunications also improve courses by widening cohort groups, and due to the cross cultural aspect, students are motivated to learn more about others beyond their own class. With Internet chat, students have the opportunity to meet and interact with peers, which brings an excitement to learning. An advantage of computer conferencing is that the student can communicate with other students, and the university, once a weakness of distance education (Daniel 1997). New technological tools facilitate two-way communication and are eliminating

two long-standing weaknesses of distance education, communication with the university and access to university resources (Daniel, J., 1998, p.148). Students can access previously inaccessible learning resources on the World Wide Web (Daniel, J., 1998, p.148). A study analyzing transcripts of on-line forums showed "...the process includes significant time engaged in social interchange followed occasionally by social discord. The social discord served as a catalyst to the knowledge construction process observed" (Kanuka and Anderson, 1998, p.3).

Collaboration is extremely important part of successful adult learning in distance education models. Peer contact has been shown to make a significant difference in course completion and final academic standing (Amundsen and Bernard (1989). Contact with a course instructor or mentor is also important for students. Student test performance was found to be poorer with ITV systems that restricted remote students' ability to converse with or see the instructor (Simpson, Pugh, and Parchmer, 1993). An analysis of problems that pose barriers to course completion reveals a cultural theme: The social contradiction between the role of student and the role of adult. "Mature distance students find this conflict in roles problematic. They have acquired the status and power of adults but find it difficult to maintain while undertaking the role of a student. Their needs for respect, personal control, and fulfillment are often frustrated which can lead to withdrawal" (Garland, 1994). Meeting student needs means letting them learn individually and take responsibility for their own learning. A research survey at the Fern University, West Germany found that men and women have different support needs during distance study. Women tended to value the chance to interact with other students more than men and attended all face-to-face local tutorials (Kirkup, G. and Prummer, C. 1990, p.1).

Although group learning has had a long history in adult education, the focus has been on group process. Recently the emphasis in the literature has been on groups as learning

environments (Sklaroff, S., 1999). Adult learning tends to be self-directed, triggered by life experiences. Reflection and action are important components of the adult learning process (Cahoon quoting findings of Merriam and Caffarella.,1991 p.34). Successful adult learning includes collaboration, interactivity, application, democracy, and sense of community. Students report the benefits of collaborative learning are: development of richer ideas, lack of feeling isolated, emotional support, more advanced thinking, a synergy created, and the combination of minds creates something greater than the sum. Conditions for effective collaboration include: Mutual trust and esteem among the partners, effective communication systems, and commitment to and control over the project by the individuals (Moran, L. 1990). Successful collaboration takes a shared goal, deep trust and respect for one another and a belief that together the group can achieve what can't be accomplished alone. (Most successful groups select each other as members (Saltiel p. 87-90).

The history of the use of groups in adult education can be traced to Eduard Lindeman in the 20th century. Eduard is considered by many to have laid the foundations for the field of adult education (Imel, 1999, p.550). Lindeman was greatly influenced by Dewey who believed that adult education was a process and that the group was the primary method for connecting experience and social action (Imel, p.55). The group facilitates individual learning (Imel, p.55). Collabortive groups usually arrive at knowledge produced jointly through the exchange of ideas, feelings, and information (Imel p,56). How group members interact affects learning. There are difficulties with collaboration, which limit the effectiveness of the group. Students report that collaboration takes more time and work, there are personality clashes and power issues, and not all members are willing to be critiqued. The group facilitator plays a key role in how these affect the group dynamics. Facilitators can foster, assist, support, and help with establishing and

maintaining the group environment by providing information about how members will work as a group.

Technology is changing the world rapidly, causing a need for continuous learning accessible to all people (Greene, B., 1997). Technological tools are changing the way we educate and deliver adult education (Cahoon, 1998). "The new tools of computer and telecommunication industry can alter the barriers of time, distance, origin of learning, and mode of delivery, thus allowing higher education to reach populations of learners and workers heretofore excluded" (Thomas, C., 1999, downloaded from WWW). Physical presence and location are becoming irrelevant as everything is available everywhere. Changing technologies are enabling a move away from site-based delivery of education to more flexible learner-selected options (Green, K. C., 1997, p.4). "Technology based distance education is emerging as an increasingly important component of higher education" (National Center for Educational Statistics, 1997). Technology is emerging as both a delivery system and a content area.

Information technology and distance education have been key factors changing education (Green, 1997, p. 4). It is rare today if an institution of higher education does not use some technology (E-mail, Web sites, chat rooms) in at least some of its programs (Green, 1997, p.4). Most higher education institutions have gone beyond these techniques to reach new audiences through distance learning programs delivered by a variety of new communications and information technologies (Comegno, 1999).

For institutions that don't start or expand distance education courses, they reported the following factors as barriers: Program development costs (43%), limited technological infrastructure to support distance education (31%), equipment maintenance costs and equipment

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failures (23%). Authorization was not a hindrance according to 79% of institutions (National Center for Education Statistics).

Distance education was first developed for use by farmers. Courses on repairing wagon wheels were offered to farmers who couldn't leave their fields (Thomas, C., 1999, p.2). By 1995 one third of institutions offered distance education courses, and another quarter planned to offer such courses within three years. More distance education courses are offered by public four-year institutions (62%) than private four-year institutions (12%) according to the National Center for Education Statistics, 1997. Distance education allows universities and businesses to expand their markets to those who might not be able to physically travel to the source of information. Higher education is now reaching populations of learners and workers excluded in the past, including retired who wish to begin a new career teaching (Strong eds, 1999, p 4).

What type of people are interested in distance learning? Distance students have family, employment, time, and travel barriers, which makes distance learning appealing. They want to study from their own homes, at times most convenient for their personal schedules. Sauve, Nadeau, and Leclerc found that there is a significant difference in the study motives, learning styles, cognitive styles, and locus of control for students registered in on-campus courses and students in an off-campus program Sauve, Nadeau, Leclerc, 1993). The National Center for Education Statistics found that the type of individual targeted for distance education courses were professionals seeking re-certification (39%) and workers seeking to update their skills or retrain (49%). The distance student can be described as being self-motivated, drawing on life experiences, and incorporating reflection and action in the learning process (Knoke, 1996, p.304). The information age is changing the economy toward a more service oriented one and students no longer choose a university by the size of the library or the number of staff. Students

seek quality and satisfaction of needs and want competitive tuition and quality (Kovel, and Jarboe, 1994, p.3).

Who develops the distance courses? For 30% of the institutions in 1995, courses were developed outside the institution. Many institutions form partnerships with companies to provide distance learning using satellite TV, Internet on-line services or distance courseware. Companies such as National University Teleconference Network (NUTN) are stepping in to offer satellite networking for higher education. Caliber Learning Network, Inc. and ZapMe! Corporation have computer labs and satellite-based Internet access for those who enter into a partnership to launch educational and testing services (Sylvan Learning Systems press release 3/31/99). External collaboration is growing. Some universities have limited investment resources and staffing, are uncertain about which techniques and methods succeed, and want to launch new programs quickly so turn to outside companies for help. Many universities are focusing on what they do best and leaving the rest up to others who can do it cheaper, so are hiring expert video companies (Knoke p 166). For example, the University of Pennsylvania chose external collaboration with Caliber Learning Network to outsource some of the workload to specialists who can produce results in a short period of time. Caliber using digital satellite communications which permit real-time lass session broadcasts and two-way video-conferencing with face-to-face contact of instructors to students (Comegno 1999). Other institutions are developing their own distance courses using technological tools such as WEBCT (referred to on page two).

How does the instructor communicate with distance students? In 1995, at 58% of the institutions, toll free telephone, E-mail or other on-line access to the instructor was available (National Center for Education Statistics 1999). In a study exploring the attitudes of post-secondary students who were negatively disposed toward distance education programs, restricted

interaction with the instructor was perceived as the major disadvantage. Increased contact with other students studying the same course was much less important than increased contact with the instuctor (Thompson, G. 1990). Teachers need to determine if students are understanding concepts as do not have the visual feedback of on-campus students. To increase opportunities for feedback, teachers can: Request student input through telephone E-mail, and mail conversations, make comments on written assignments that are specific and encouraging, use non-graded quizzes or exercises to guage student comprehension, and have students measure their own progress through self-assessment items.

How does the distance student do research? Distance learners had access to the university library at 56% of the institutions and 62% had cooperative arrangements for students to use other libraries (National Center for Education Statistics 1999).

How do institutions evaluate students? For 98% of the institutions, some type of test was administered. An administrator gave the test at remote sites for 30% of institutions and 15% had tests individually mailed or faxed to students. Tests were offered at remote sites via compute, video, or telephone for 8% of institutions. (National Center). Sylvan Prometric is one company that delivers computer-based testing for academic admissions and professional certification programs. Software such as Java Scripts offers the ability to take tests via the web.

When institutions were asked what the most important benefits of distance education are, 82% said distance education increases student access by making courses available at convenient locations, 64% said it increases university enrollments, 63% said it reduces time constraints, 50% said it makes educational opportunities more affordable, 46% said it improves course quality (an important goal), and 20% said it reduces institutions' per student costs. "Decades of research on distance delivery methods show that well-designed distance education is as good or better than

Educators helped the Internet idea spread into the public domain, via electronic mail (Bard p.13). In the late 1980's the Internet became overwhelmed with traffic and commercial Internet providers, who saw the profit potential, began providing larger, faster phone lines, expanding the Internet resources (Bard p.13). In the late 1990's, Web browsers (software tools used to access the Web) appeared.

"The Internet caters to different types of learners, having print, sound, pictures, and vide resources. It is a culturally, racially, physically, sexually blind medium" (Bard p.36). The Internet provides educators with a way to communicate with peers, and to belong to a professional community with a strong common goal which provides a place for teachers to reflect on current practices and ideas (Serim and Koch 1996, p.149). For educators, communicating with others can break down the walls of isolation, and the exchange of ideas can be inspiring. Instructors and students can share solutions to problems as well as ideas, getting many different perspectives. Due to the need for flexibility in distance education, collaborative rather than co-operative activities are seen as more appropriate. Synchronous activities should be optional and should be planned and managed by the students themselves as much as possible. Internet-based course designers need training in collaborative learning (Chomienne, Basque, and Rioux 1997). A survey of students and faculty on the advantages, disadvantages, and general effectiveness of using the Internet as a teaching and learning tool found that "the benefits include: Meaningful learning of technology through the integration of course content and computer applications, increased access to the most current and global content information available, increased motivation, and convenience. Faculty reported the following challenges in the development and delivery of Web-based instruction: Lack of technical support, lack of

software/adequate equipment, lack of faculty/administrative support, the amount of preparation time required to create assignments, and student resistance" (Daugherty and Funke, 1998).

Not everyone assumes that information technology is automatically equated with progress. Two professors, Hank Bromley and Thomas Jacobson of The State University of New York, want to create a community to question common assumptions about computers and data networks such as whether educators should teach computer literacy or whether the computer industry should pay for this training (Young, 1999, p.1). It is the consumer who decides which technological tools are successful. An example of an unsuccessful tool is the picture phone developed by AT and T. Only a few hundred sold after the company spend a lot of money producing it. The phone lines and computers weren't powerful enough to carry high quality video images and although people wanted to see who they were talking to, they themselves didn't want to be seen (Kaku, p.48b). CB radios are another example of a product that was just a passing fad. Some people feel the Internet is just a fad, although most people see that the Internet is becoming an indispensable part of our lives that is changing and enriching our lives.

There are problems caused by the Internet such as concerns regarding ownership of ideas. There are questions about copyright and intellectual property rights, privacy of students' records, control of access to objectionable materials, and academic honesty. Information is readily available on the Internet which increases the probability that students who are inclined to do so will steal the work of others and present it as their own. Some web sites offer research papers for sale (Cahoon p. 66). Another problem society is facing is that Internet based education separates the haves and have-nots. Some students can't afford the hardware, software and Internet service. Most users pay for their own Internet access according to the American Internet User Survey (Cahoon p 67). Another problem is keeping up with the exponential rate at which new hardware

and software are introduced- there's the cost of updating along with the initial equipment costs. The fast rate of technological change makes it difficult if not impossible to attempt to standardize educational practices.

There are still problems to be resolved with technology. One of the problems with desktop videoconferencing (using a computer to send and receive video, audio and text in real time via the Internet) is the limited bandwidth (the amount of information that can be transmitted per second). The bandwidth of the telephone lines is insufficient and delays transmission of data. The lines were meant for voice and don't handle video signals well. Video contains more information so requires a much larger bandwidth (information capacity). The limited bandwidth causes delays in movement, such as choppy, jerky video and a voice which isn't always in sync with mouth movements. Low-resolution images are hard to see (poor quality). Delivery of interactive multimedia content via the web means lengthy download times and the need for software plug-ins for delivery of multimedia. Congestion over the data transmission lines causes a bottleneck on the Internet and delay in transmission of data. When the bandwidth improves, it is predicted that the killer application will be movies on demand (Kaku, 1997, p.52). Bandwidth grows by 50% annually (Devhead, Dec. 1, 1998). Meanwhile, a partial solution is to utilize CD/Web hybrid technology, which merges the CD-ROM and the World Wide Web. Companies create web sites that can be played off a CD-ROM to deliver educational content over the Web. The delivery isn't restricted to slow transfer speeds. CD ROM drives are faster than the modem of the typical web connection. CD ROM (read only memory) video disc players are fast being replaced with the Digital Video Disk (DVD) ROM because they hold more information (DVD newsletter/web site).

In 1996 the Federal Trade Commission and the TV and computer industries agreed to adopt digital as the standard mode of transmission which helped merge the TV with the computer, making TV interactive. The TV of the future will have double the resolution and will be digital (Kaku, p.56). In describing how almost all information will be in cyberspace, Gordon Bell and James Gray say " The most significant benefit will be a breakthrough in our ability to communicate remotely with one another using all our senses (Metcalfe, R. and Denning, P., 1997, p.1).

Companies such as the satellite and cable companies are racing to see how to get information into homes in the shortest amount of time. Many large corporations choose to have a dedicated cable line for high speed and wide bandwidth communications (called an Integrated Services Digital Technology Line or ISDN). This line can handle large amounts of information, however there is usually a fee for installation of the cable and a usage fee (VISC Web site1999). Other companies such as White Pine Software of Nashua, New Hampshire offer multimedia conferencing applications for the Internet and Intranets for multi-group conferencing. Prices range from $8,995 for a 10-user server to $15,995 for a 25-user server (White Pines web site, 1999).

What type of technology is used to deliver distance education courses? In 1995 the National Center for Education Statistics found that two-way interactive video and one-way pre-recorded video were used by 57% of institutions. Two-way audio with one way video, and computer-based technologies other than the Internet were used by 25%.

Which tools are best? Two uses of computers for teaching in distance education were compared and contrasted: Systems based on pre-programmed learning materials (such as computer assisted learning where the learner communicates with the computer) and systems

based on communications functions of computers (E-mail, data bases, conferencing). For distance teaching at the higher educational level, the latter offered the more appropriate route for future development (Bates, T. 1986). A study of training effectiveness and user acceptance of live instruction was done by ITV Net (a web cast provider founded in 1995, which makes the Internet a broadcast medium for entertainment, business and education. It has helped the Department of Education broadcast on the Internet) comparing six different instructional TV technologies: multi-channel two-way audio, single channel two-way video with two-way audio, one-way video with two-way audio, one way video with one-way audio, one way audio with intermittent two way audio, and audio graphics. When compared to live instruction, the study found instructional TV was effective both in terms of student performance and acceptance (ITV web page 4/1/99). The most successful ITV technologies were those allowing two-way audio communication between classrooms with either two-way or one-way video (Simpson, Pugh, and Parchmer, 1993).

TV and computers serve very different sociological and behavioral needs. The computer allows consumers to interact with data. TV is much broader and more accessible. It allows multiple viewers to experience the programming. The advantage of satellites is that no wires need to be laid, but hundreds would need to be launched. Cable can broadcast video at high speeds and companies are beginning to offer fast Internet access, using boosters to amplify signals over long distances. Companies will probably change from using copper wires to laser fiber optics to deliver Internet service, as the laser beam can carry10 to 100 times more information than copper wires (Kaku, 1997, p.54).

There is no one best way to use technology in the classroom and there is no one best technology for every teacher to use (Penrod, 1998, p. 11). Technology is suited to support

collaborative activities (Penrod, 1998, p.11-12). In 1993, the center for technology in education did a survey of K-12 teachers involved in using telecommunications. Eighty three per cent of teachers had been teaching 10 or more years and 82% used technology in their teaching. All were using it in different ways for different things (Gates, 1996.p.35).

Some, institutions, like Western Governors University offer virtual courses. Similar to companies like Amazon.com, the university provides a central Web site that highlights distance-learning opportunities already offered at member universities and colleges. Students can search for a course and enroll and start working toward a degree (Western Governor's web page, 1999). Jones International University, another virtual institution offering degree programs on-line was the first on-line university to get accredited by its regional accrediting body (Blumenstyk, 1999). Information technology is being used to enhance courses, curriculum, and student learning (Green, K. 1997, p.5). In order to meet the needs of working adults, universities must offer courses and training at a time and place convenient to them (Wallhaus, R., 1996, p.11). Adult students need flexible admissions policies and curriculum based on their needs. There is an opportunity for universities to provide learning to older adults who choose to remain working and for retired who choose to begin new career teaching.

The teachers' role is changing from being the one having access to information and controlling it's flow to students, to the student being responsible for his/her own learning and obtaining his/her own information. Technology is changing the teachers' role from one of disseminator of knowledge to one of facilitator: One who helps guide students seeking knowledge so that they can be lifelong learners. Teachers need to teach students to be lifelong learners, to recognize when information is needed, how to locate it, evaluate it and use it effectively (Green, K, 1995). Teachers need to focus on individual learning, instead of group

teaching (Daniel, J., 1998, p.16). It is now important to teach critical thinking skills, information literacy and understanding of collaboration, and may no longer be necessary to teach content (Tripathi, A. K. 1999, May). The Internet and the World Wide Web are replacing content teaching and will soon become most of the infrastructure a college or school needs (Tripathi, 1999). We need to teach students to identify quality information from the web and to authenticate sources (Tripathi, 1999).

As the teacher's role in the classroom changes from dispenser of knowledge to facilitator of student learning, the curriculum planned by the teacher and guided by textbooks needs to change (Serim and Koch, 1996, p. 150). Current curriculum is designed around the teacher controlling information and needs to be updated to where it isn't confined to the classroom and meets the needs and interests of individuals. Most universities are still focusing on group teaching with technology instead of individualized learning (Daniel, J. S., 1997, p.5). Faculty need to provide the conceptual framework and motivation to students to seek and integrate new information. They need to introduce students to the Internet and show them how to acquire information and how to critique it. Given the certainty of technological change, we face the need for continuous learning (Cahoon, 1998, p.12).

Information Technology is providing access to better learning options such as the change from the university library as students' primary information source. Technology has provided students with access to networks where students can pick from an array of documents, literature, and research on the Internet, which is easier to search and faster than walking to the campus library. Technology is reducing the costs and enhancing the quality of the library. "With good learning materials, effective networks and proper support, students can learn better at home than in class" (Daniel, 1998, p.16).

According to Dr. David Thornburg, (Canter 1998) There are two ways to use technology. One way is to automate- put it on top of something that already exists, such as computerizing the process of grade reporting. The second way is to change the mindset and think of what can be done now that couldn't before, such as bringing real world problems to the classroom, giving students new types of problems to solve.

Typically educators begin by using web tools to supplement courses such as publishing the course syllabus or having the students send E-mail to the teacher. Next, they provide links to web sites and related topics, then have students submit assignments to the instructor, or to a class web site. Some use on-line conferencing, mailing lists, and newsgroups where the teacher and students can read and contribute to messages (Cahoon, 1998, p.26-27).

Universities will need to invest in technology in order to remain competitive, to enhance teaching and learning, and in order to prepare students for the changing job skills they will need. Many institutions are just beginning to make capital investments in computers, telecommunications, technical and support staff (Green, and Gilbert, 1995).

Universities should plan how technology can be used best to improve teaching and learning. Besides improving administrative productivity by using word processing, spreadsheets, electronic mail and automated registration, technology can enhance teaching. Computer based simulations can be used to show three-dimensional things being studied, like molecules. Also the content of the course can change to create things on the computer such as songs. The investment of technology use should be in the area of changing course content, as this will improve the quality of courses and make the qualitative difference in the way we teach (Green and Gilbert , 1995, p.10).

Universities will need a technology strategy as new technology brings radical changes to higher education and students have worldwide choice of universities. The strategy has to be perceived by the whole university as a way to convert a desirable vision to reality, in order to have staff support. The university needs to look at the talents of the staff and think of hardware as an operating expense instead of a capital expense. Universities must look at costs beyond the initial wiring, such as replacement of equipment, user training and support costs.

As of 1996, only 28% of universities had a financial plan for replacing computers and software according to the annual campus computing survey (Greene, October 1997 AAHE bulletin article A3 p.3). As Bates said in 1995, even institutions that do not elect to teach students off campus will need to adopt some of the approaches that have been developed for distance education (Daniel, 1997).

With the growing number of non-traditional students, universities must overcome concerns about time, distance, and money that traditional students don't have. "Through widening choice, technologies could empower individual learners on a global basis by making education more focused on their needs rather than those of the local providers of education" (Bates and Gpe, 1997). On-line learning offers potential solutions to these concerns (Cahoon , 1998, p. 60). Cahoon makes the following recommendations for universities creating non-traditional courses: Create a team of developers made up of a technical person, a subject matter expert, an instructional designer, and a student. Allow time for the team to experiment and evaluate the course. Test with a mini course and begin with just a few courses before expanding gradually. Continuously revise and improve courses. Pierre Levy in the book Collective Intelligence states that we can't learn fast enough so need to collaborate (Engelbart article, no

date available). Some universities collaborate to share resources such as state universities share faculty, courses, libraries, and instructional materials.

Summary

Computers, E-mail and the Internet are changing the way we communicate, teach and learn. Technology is changing the way knowledge is shared and delivered, causing changes in the teachers' role and in the way institutions need to educate professionals (Kull and Halal, 1998, p.4). In our technological society, one time knowledge has become outdated and individuals need to continually update skills. Learning on demand and continuous learning are taking the place of the one-time education (Kull and Halal p.4.).

Cable and satellite companies are racing to overcome the limited bandwidth problem of the phone lines and collaborative partnerships are forming for delivery of interactive distance communication. New technological tools are being used to improve course quality and to provide distance education to the new service-oriented consumer. "The growth of distance education has eroded the geographical constraints on institutional rivalry" (Daniel, 1997 p.138) and distance learning is allowing people to study through universities without ever leaving home.

Technological tools facilitate virtual meetings and group collaboration, an important component of adult learning. They are motivating students to participate in their education and are connecting students to colleagues, the teacher, the university and the library. Technological tools improve course quality by widening the cohort groups, giving students more practical experience.

New technology is eliminating the barriers of time and distance, challenging the existence of traditional, geographically based campuses and curriculum based on textbooks.

Universities will need to change update curriculum to conform to changes in the teachers' role from provider of knowledge to facilitator of life-long learning.

What institutions must do to survive the future can be seen on the cover of magazines and books: Plan carefully, think differently (from the cover of the Spring 1999, *The Strong Investor Magazine).* "Using new tools to support new approaches means the 'unbundling" of teaching and learning into many component parts. Each of these components- information presentation and delivery, schedules and timelines, learning activities, engagement and interaction, ongoing evaluation and testing, available additional resources and expertise- can take many forms and use many strategies, this permitting a customizing of learning opportunities previously not possible" (Dillion and Granger, 1998). The choices institutions and companies make now will shape the way they evolve (Engelbart, D and Engelbart, Bootstrap Principles p. 454). Universities need a technological plan based on a vision and need to invest in using technology to improve course content and quality. Technology means investing in and maintaining equipment but also provides an opportunity to cut costs through automation and distance learning. Technology provides an opportunity to make a university attractive by offering customers a unique service.

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HOW INFORMATION TECHNOLOGY IS CHANGING EDUCATION

LITERATURE REVIEW ABSTRACT

This literature review paper looks at the four information technology fields (computer hardware, computer software, communications, and information services) which are changing the way we communicate, teach, and learn. It describes the change in the way knowledge is shared and delivered and looks at the teachers' new role in education.

The paper reviews the new technological tools are being used to improve course quality and to provide distance education and looks at the advantages and problems they cause. New technology, which is eliminating the barriers of time and distance, is also challenging the existence of traditional, geographically based campuses and curriculum based on textbooks. Universities need to update curriculum to conform to changes in the teachers' role from provider of knowledge to facilitator of life-long learning.

Technological tools facilitate virtual meetings and group collaboration, and are motivating students to participate in their education. Tools are connecting students to colleagues, the teacher, the university and the library and are improving course quality by widening cohort groups. Technology provides an opportunity to make a university attractive by offering customers a unique service.